Unmanned aircraft systems Chromatograph for Atmospheric Trace Species (UCATS)

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ATTREX Instrument Payload - UCATS

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Instrument Description / Measurement Characteristics:

UCATS is a combined instrument with two gas chromatographic channels (GCs), one ozone (O_3) UV absorption photometer (2B Technologies), and one water vapor (H_2O) tunable diode laser absorption spectrometer (Maycomm, Inc.). It measures nitrous oxide (N_2O) and sulfur hexafluoride (SF_6) every 70 seconds on GC channel #1, and can measure hydrogen (H_2), carbon monoxide (CO) , and methane (CH_4) every 140 seconds or measure chlorofluorocarbons CFC-12 (CCl_2F_2) and CFC-11 (CCl_3F), and halon-1211 ($CBrClF_2$) every 70 seconds on GC channel #2. Water vapor is measured every second and ozone is measured every 10 seconds. Water vapor has two cells with different pathlengths to measure both stratospheric and tropospheric concentrations.

ATTREX Instrument Payload - UCATS

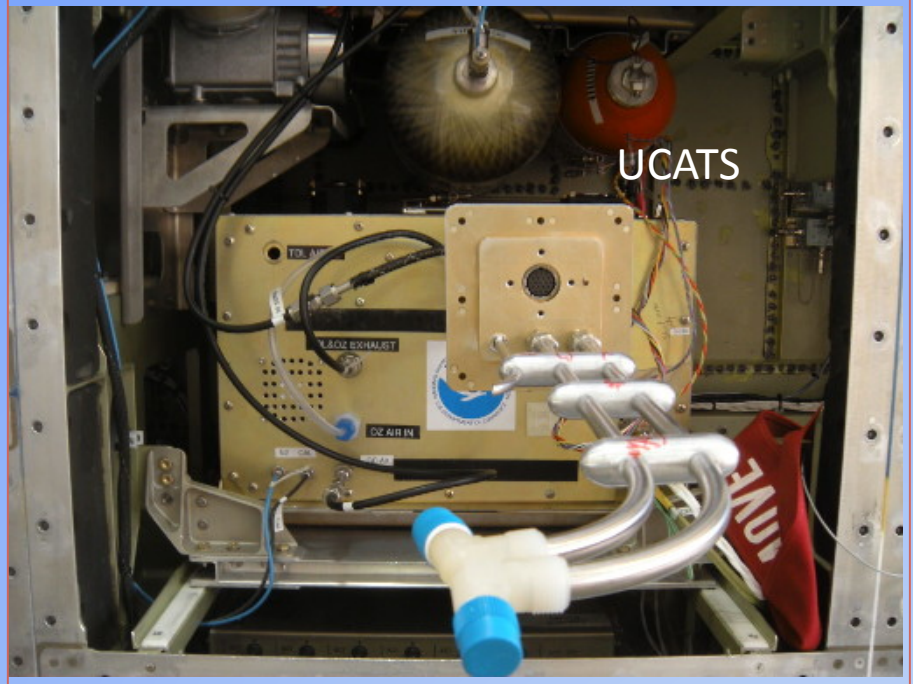
Instrument specifications:
Mechanical and Electrical

Size: Main box - 46 x 41 x 25 cm (18” x 16” x 10”)
Weight: 27 kg (60 lbs.) excluding gas bottles (2), inlets, and pump.
Power: Start up < 500 W, Normal 280 W
Inlet probe: Two 3/8” lines
Exhaust port: None. View ports/windows: None.

Hazards (Lasers, Pressure vessels, Compressed Gases, Chemicals, Motors/Pumps, Batteries, etc.):

a. One nitrogen carrier gas and one air (bottle) bottles, two 500 cc bottles of pure N_2O and CO_2 (all non-flammable).
b. Two Ni-63 10 mCi excepted radioactive sealed sources (safe for passenger aircraft)
c. Small NiMh (Nickel-metal hydride) batteries for computer backup.
d. Sealed IR diode laser for H_2O Tunable Diode Laser.
e. Small quantities (< 100 grams) of absorbents.
f. 2 actuators for valves, 4 solenoid valves, and 1 pump

Instrument Photo:



Instrument Requirements:
Control and Communication

Control Switches: None.

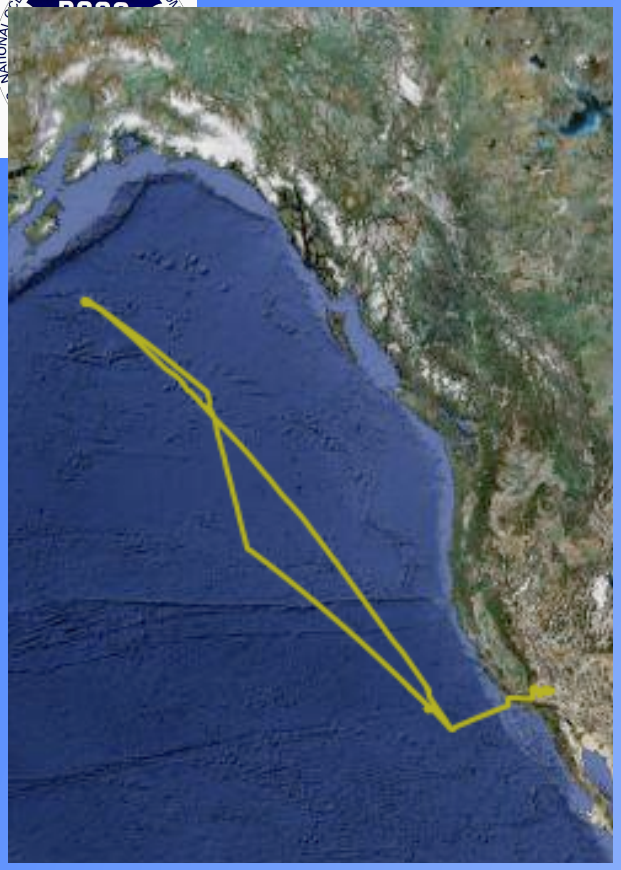
Communication Bandwidth: Two feeds: (1) Ethernet to GH data system, <1kB/min, (2) serial is 3456 bits/sec.

Nav / Time inputs: None required.

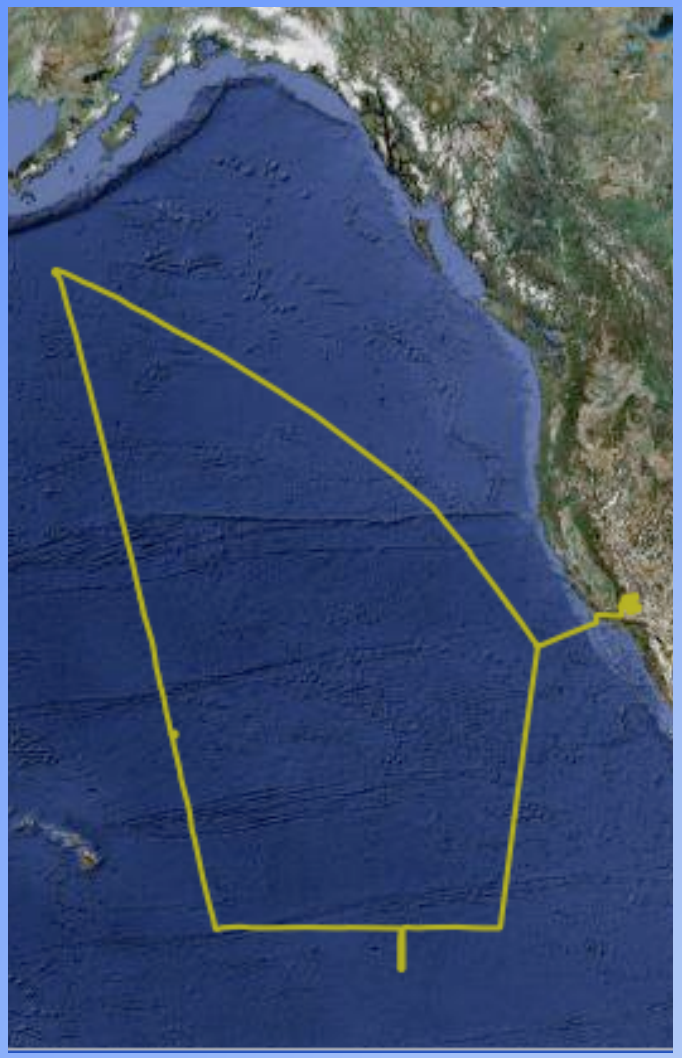
Instrument Modifications:

UCATS was flown on NASA Altair UAS during NOAA UAS demo of 2005, and NASA Fire Mission 2006, and on the NSF GV for START08. UCATS also has operated on the GV for HIPPO/1 (Jan. 09) and HIPPO/2 (Nov. 09). UCATS was flown on the Global Hawk during GloPac in April-May 2010.

GloPac Flight Tracks (Three of Five)



April 7th
14 hrs, 4600nm, 61200 ft



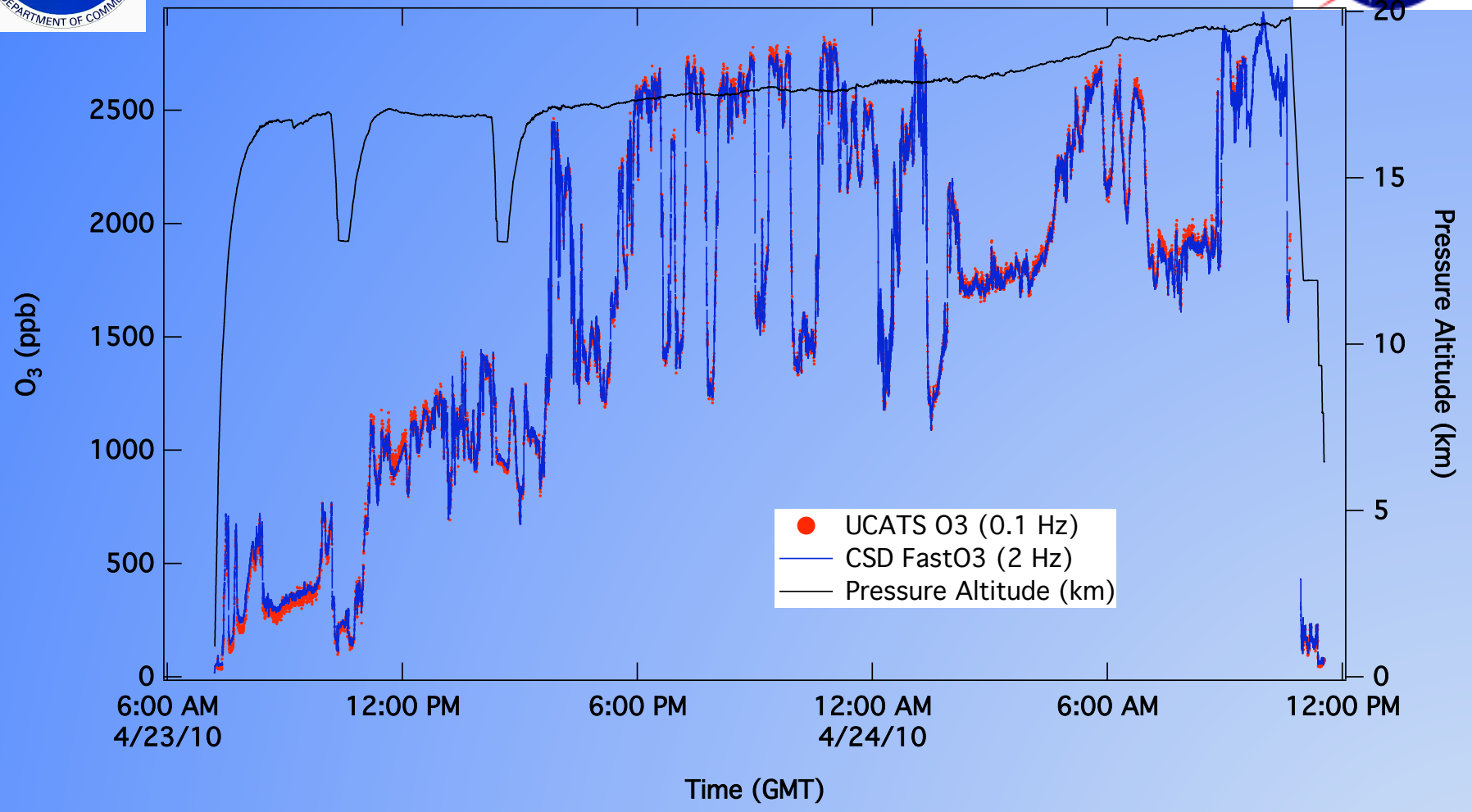
April 13th
24 hrs, 8000nm, 62300 ft

April 23rd
28.6 hrs, 9700nm, 65200 ft

Subtotal: 66.6 hrs

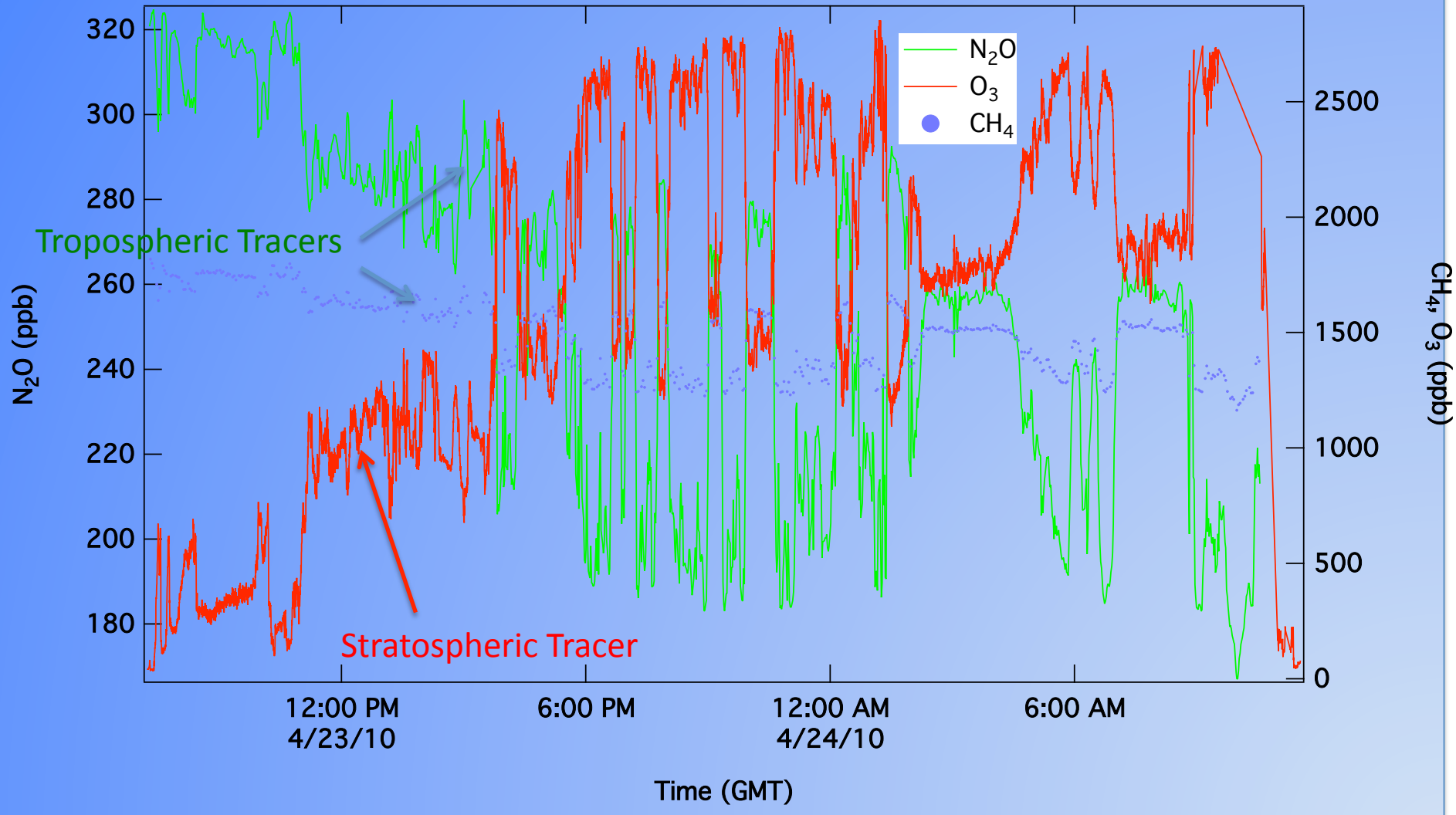
(2 Apr. test flight: 6 hrs)

Ozone Comparison 2010 Apr 23

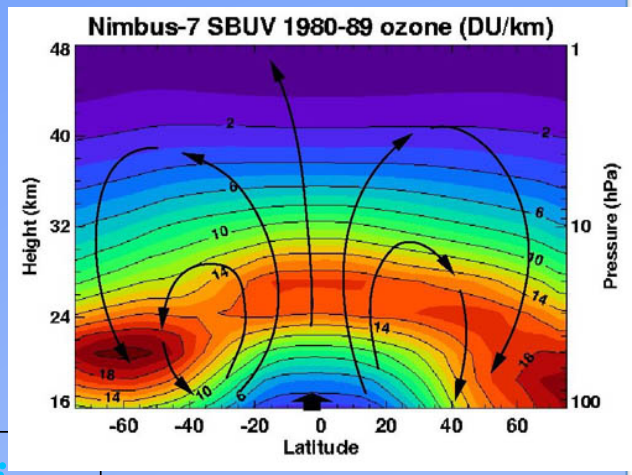


Preliminary CSD results from R. Gao

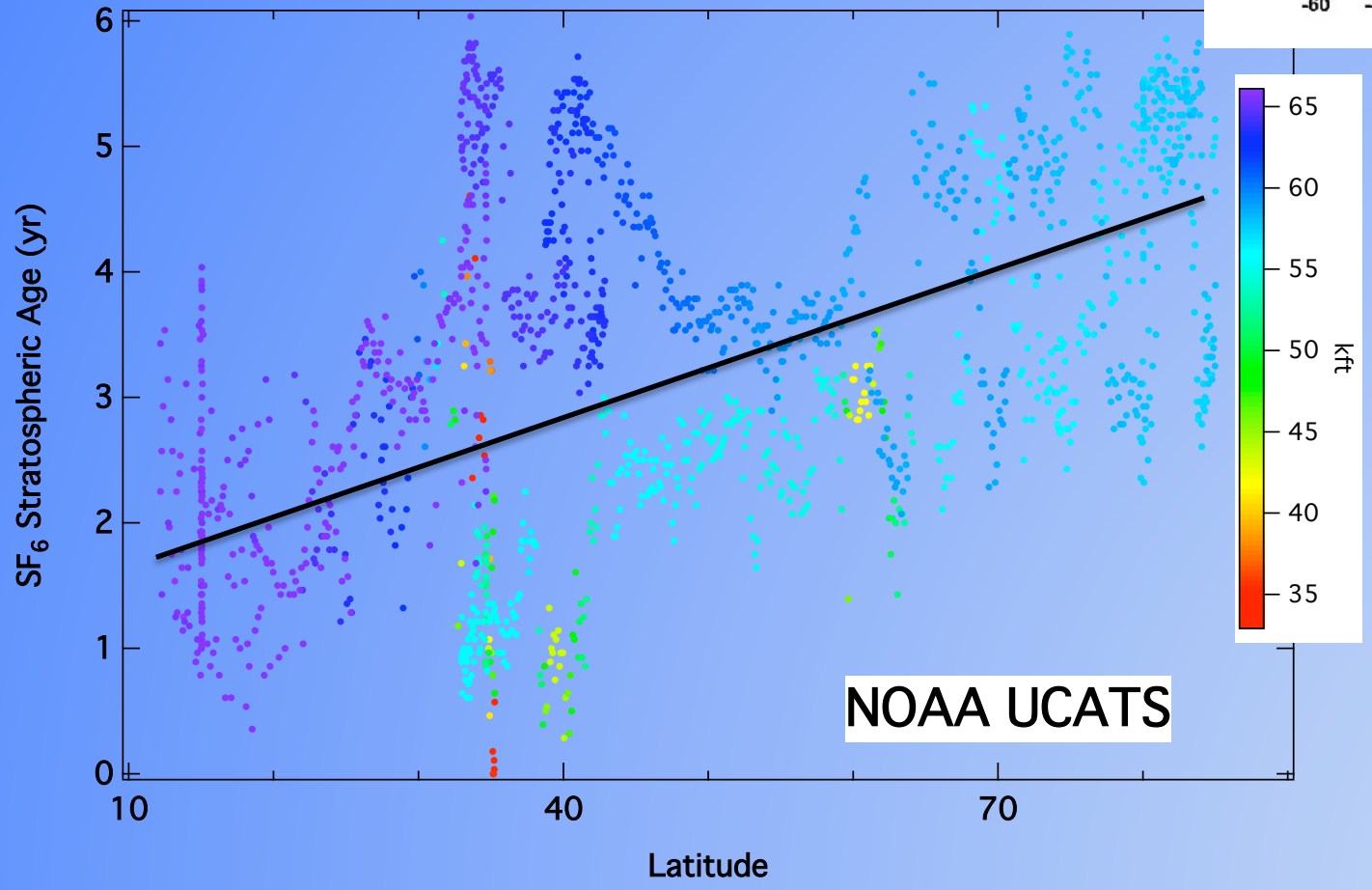
Tropospheric (N_2O & CH_4) and Stratospheric Tracers (O_3)



Latitudinal Profile of Stratospheric Age



Brewer-Dobson Circulation: Age Increases with Latitude



1. Description of the science issues and their importance

- **Aura Satellite Validation of trace gases (N_2O, CFCs, CO, CH_4, H_2O, and O_3).**
- **Ozone chemistry (O_3, ozone depleting substances (ODS), BrO).**
- **Transport (clocks, CO_2 and SF_6, photolytic tracers)**
- **Water vapor.**
- **Asian air pollution and dust episodes.**
- **Bromine chemistry.**

2. How ATTREX (& other) measurements can be used to address the issues.

- Need trace gas data above and below Global Hawk to address transport questions
  - Satellite over flights (MLS, Omni, OCO)
  - DC-8 or GV tropospheric sampling underneath.
  - Balloon launches with ozone and water vapor –sondes
- Really important to sample near ground based stations (or their latitudes) to set the CO_2 and SF_6 transport clocks and other trace gases (NOAA, AGAGE, GAW)

3. Specific sampling strategies required (i.e., flight plans)

- Need latitudinal survey flights up to the Arctic, preferably in springtime (test flight series?)
- Flights to the tropics during all seasons.
- For the trace gases, we need profiles. The lower the better.
- Not a good idea to give up on Hawaii deployments possibility (lower costs, better access, near Mauna Loa Climate Observatory).